This scenario supports the following competencies: IH 1.2, 1.3, 1.9, and GTB 5.5.

Scenario 1: ***Question***

A pilot chemical-batching process has been initiated at a DOE facility. The batching process involves three two-thousand-gallon steel tanks in which waste water contaminated with lead and chromium is treated to remove these heavy metals. The foreman supervising the construction and start-up calls you to report that a recently hired worker who was involved with the initial test batch treatment was just sent for medical attention after suffering what was thought to be an asthma attack. The supervisor indicated that the worker complained of an acrid irritating odor before the attack. The supervisor also indicated that the odor was pervasive, but that this occurrence is not unusual for this type of start-up activity.

a. What are your initial actions in response to the problem?

b. What resources would you use to identify the potential causes and sources of the problem(s)?

c. What measurements would you make:
   1. To pursue your theory as to the cause of the problem?
   2. To quantify the exposures of personnel?

d. What controls should be considered:
   1. To control the problem at this plant?
   2. To prevent similar problems in the future?

Scenario 1: ***Answer***

a. Your initial actions in response to the problem should include determining if: (1) operations are still ongoing, (2) other personnel are still exposed, and (3) controls have been established to reduce further personnel exposure (e.g., PPE, isolation, and temporary ventilation, as feasible). You should also visit the work site and interview the supervisor, affected worker, and coworkers to get the following details about the incident:
   - Date, time
   - Site, location
   - Operational details of ongoing work
     - In the affected worker's area
     - In the surrounding workers' area

- If there were similarly exposed persons
- What chemicals were or had been used in the area

b. The resources that would be helpful to you to identify the potential causes and sources of the problem include:
   - Construction plans - describes the tasks or operations
   - Chemical inventories/MSDSs - chemicals, constituents, and dangers
   - Condensed Chemical Dictionary - for MSDS chemical names and cross references
   - SAX Properties of Industrial Materials - toxicology references, immediately dangerous to life or health (IDLH), threshold limit value (TLV), routes of entry
   - NIOSH Health Hazard Evaluations - product use in industry
   - Patty's *Industrial Hygiene and Toxicology* - general industrial hygiene (IH) information
   - International Labor Organization Encyclopedia of Occupational Safety and Health - general IH information

c. Sampling methods will be determined based on the information obtained from the resources listed in answers a and b.

   1. To pursue your theory as to the cause of the problem, initial sampling will be done to capture and learn the general characteristics of transient contaminants. For example, an ambient air-grab sample could be collected and analyzed by GC-Mass Spectrometry, which has the capability of identifying the type and concentration of contaminants in the sample. An additional option to quickly screen and narrow down the possibilities from several contaminants would be to use nonspecific hydrocarbon analyzers, acid gas and aldehyde detector tubes, and direct reading instruments that measure oxides of nitrogen and carbon monoxide.

   2. To quantify the exposures of personnel without specific contaminant information (process, chemical, etc.), you are guessing as to what sampling media and methodologies to use. So, focusing your sampling strategy is done by:
      - First, evaluating research data - operational, historical, material, exposure, etc.
      - Second, using appropriate screening techniques for the suspected stressors.
      - Finally, using specific sampling/measurement techniques to quantify the stressors.

      Data collected in answer b will help identify the probable contaminant(s) that caused the adverse reaction to the employee in this scenario. Consult the analytical laboratory to determine the appropriate sampling method(s) and obtain the proper media for the probable contaminants. Next, you would collect a series of breathing zone samples (to quantify worker exposure) and area samples (to quantify the ambient concentration).

d. For the scenario presented, control methods should be selected based on the following priorities:

1. To prevent more personnel injuries and reestablish operations, implement: hazard communication training for the chemicals identified; the wearing of PPE with appropriate training; the screening and surveillance of employees to ensure appropriate medical qualifications; isolation of the area with appropriate postings; temporary ventilation; and the shutdown of operations as necessary.

2. To control contaminant releases: establish permanent ventilation; apply sealant or coatings; institute chemical substitution/replacement.

3. When establishing processes during the design or redesign phase, ensure that hazards associated are identified and eliminated. Strive to use materials that eliminate contaminants, and therefore, the need for controls during this operation. Involve an IH as an integral part of the redesign team. This should include work planning that involves all affected parties and appropriate technical experts including process designers; customers; engineers; installers; operators; and environmental, safety, and health personnel.

This scenario supports the following competencies: IH 1.4, 1.9 - 1.12, 4.3, 4.5, and GTB 5.5.

Scenario 2: ***Question***

Development of a new site remediation treatment process to extract contaminants from the soil has begun at your site. Engineering Design Developers (EDD) has been awarded the contract from the management and operating (M&O) to design, construct, and field-test this new chemical treatment process. As the DOE industrial hygiene representative, you have the responsibility of working with the M&O to oversee the entire project. The EDD contractor foreman has not yet consulted you on any IH issues.

a. Since you are included in the initial phase of this project, what are your opportunities for involvement in this situation?

b What are your concerns?

c. What are the potential barriers to ensuring that the new process is implemented safely?

d. Describe how your concerns should be addressed during this project and future projects.

Scenario 2: ***Answer***

a. Your opportunities for involvement in this project include the following:

1. Preliminary IH involvement during the design phase of projects can help to identify and eliminate risks. Cost-effective and safe methods reduce the potential for accidents, over exposures, and environmental incidents.

2. There is an opportunity to be involved in decisions of design processes that determine what hazards are brought into the workplace and how they can best be controlled.

3. Set the standard for early IH involvement in decisions that affect the environment, health, and safety of employees.

b. You should investigate the following questions:
   - Is this the first time you've heard of this process?
   - Has EDD asked for your input on information about the hazards of the chemicals used and produced?
   - What chemicals are used in this process and what are their safety and health consequences?
   - Are these chemicals EPA-regulated?
   - What are the by-products of production?
   - Are any of the chemical constituents or by-products carcinogenic?
   - Do the chemicals used and produced have occupational exposure and environmental release limits?
   - Will air- or waterborne releases require permits?
   - How far along is the design process and what other groups will be involved?
   - Will this project require input from worker groups, community groups or the maintenance department?

c. The potential barriers to ensuring that the new process is implemented safely include:

   1. Preconceptions that industrial hygiene safety is a barrier to production.

   2. Preconceptions that industrial hygiene safety is only the IH manager's (your) responsibility.

   3. Failure to understand that implementing safety and health operations at the onset will ultimately reduce waste, save money, and perhaps even save lives.

   4. Reluctance to change.

   5. Communication problems between IH and the management team.

d. Addressing concerns during this project:

   1. It is appropriate work practice to privately meet with managers and foremen to discuss the project and obtain the following information:
      - Ask for the specifics of the treatment process:
        – the names of the chemicals used and produced
        – known intermediate products
        – by-products
        – wastes and chemicals produced during abnormal production events

  - thermodynamic data
  - physical properties
  - toxicological data they have on the chemicals used and produced
- Have alternative chemical reactions been investigated and, if so, what were they?
- Who has been involved in the project so far?
- How far along is the design process?
- What were the production process alternatives?
- Had Process Safety Management (PSM) requirements been considered?
- Had any failure mode analyses been done on the processes being considered, and what were the results?
- Discuss how IH involvement in the project will save money and prevent future problems.

2. Present any information gleaned from previous meetings and follow-up research done on the hazards of the chemicals involved and similar processes.
   - Demonstrate how IH involvement can help the project succeed.
   - Present case histories of poor chemical safety management and personal liability consequences of the wrong decisions.
   - Based on the projected quantity of chemicals used, present the PSM requirements that must be met.
   - Introduce the tenets of Responsible Care of Chemical Manufacturers.
   - Call together a team with highly experienced representatives from all environmental, safety, and health departments. Ask workers to go through the design process and develop the best and safest process.

3. Upon completion of this project, institutionalize this design process in policies and procedures manual. This should include all department involvement throughout the design process including conceptual designs; 10%, 30%, 90%, and 100% plans; and acceptance testing of the completed facility.

This scenario supports the following competency: IH 1.16.

Scenario 3: ***Question***

Though your primary income is derived from your employment as a DOE industrial hygienist, you moonlight as a consultant for ACME Healthy Environments, Ltd. In joining ACME, you were required to sign a confidentiality agreement prohibiting you from relating anything you see or hear while in its service. The purpose of this agreement is to ensure the protection of the intellectual property, etc., of ACME and its clients. The form you sign threatens grave consequences for any person violating this agreement.

While working for ACME, you visit a small manufacturing establishment (Friendly Community Paints, Inc.). In order to assess the company's compliance with a new OSHA expanded standard (the company is required to have compliance with the new standard verified in order to be qualified to accept a government contract vital to its future). On the site, you observe an operation that in your professional opinion will almost certainly cause employees performing it to be exposed to concentrations of a harmful chemical agent above the ACGIH TLV, but probably not the OSHA PEL. Overexposure to the chemical agent in question can cause serious and irreversible effects. While determining site compliance with the medical surveillance requirements of the OSHA expanded standard, you determine that some employees may be experiencing the early (but not yet serious or irreversible) effects of exposure to this chemical.

You complete your assessment of the company's compliance with the OSHA expanded standard and determine it to be excellent. Given this encouraging sign, you mention to company senior management the potential problem you have observed with the other harmful chemical agent. Senior company personnel become defensive, informing you that: (1) these additional observations were not what you were hired to do, (2) the company is, by your own admission, likely to be in total compliance with all applicable laws, and (3) the company has met the requirement to receive the government contract. They pointedly remind you of the confidentiality agreement that you signed and threaten action if you say or do anything that damages the financial future or reputation of the company. They bid you "have a nice day."

You note the confidentiality agreement you have signed. You also know that the AIHA/ABIH *Code of Ethics for the Practice of Industrial Hygiene* requires that you keep confidential personal and business information obtained during the exercise of your activities, **except when required by law or overriding health and safety circumstances.** You are a member in good standing of both organizations and want to stay that way. What do you do?

Scenario 3: ***Answer***

The agreement you signed to protect the confidentiality of your employer and Friendly Community Paints, Inc. is inflexible (and may be illegal). A similar requirement in the *Code of Ethics* does allow you to take action when there are overriding health and safety circumstances. Another canon of the *Code of Ethics* requires you to take action to protect the health of employees. As a consequence, you can take the following actions:

1. You convince the president of ACME of the necessity of communicating in writing to Friendly Community Paints, Inc., about the potential overexposure and adverse health effects you have observed. You are professional but blunt and use unequivocal expressions such as "serious and irreversible health effects for which the company and its senior management may be liable for both criminal and civil penalties." You inform the company that you believe that the problem can be fixed quickly and you volunteer your services (management's response or lack of it may give you an indication of their intentions). You ensure chain of custody for this letter, documenting its arrival in the hands of Friendly Community Paints, Inc., senior management.

2. If a favorable response is not received, you (as an individual) should consider whether additional action must be taken to protect the employees of Friendly Community Paints, Inc. If you decide this action is necessary, your only option is to inform the appropriate regulatory agency (probably federal OSHA). You may make your complaint anonymously if necessary, and because you can give a detailed and graphic description, it will probably be followed up quickly. Providing your name will document your attempt to get the problem fixed, but it may make you liable for legal action by Friendly Community Paints, Inc. or ACME. There is also the possibility that an inspection by an OSHA industrial hygienist will not result in corrective action. You already doubt exposure above the PEL. Despite this fact, the OSHA area director may decide to issue a citation under the General Duty Clause if an otherwise unregulated serious hazard is present. In either case, in referring the issue to OSHA, you have met your ethical obligations to the employees of Friendly Community Paints, at some risk to yourself.

This scenario supports the following competencies: IH 1.1 - 1.3, 2.1, 4.5, and 4.8.

Scenario 4

Question a

Plans are announced to renovate an inactive industrial building built in the 1950s. This building at one time contained various types of unit processes involving chemicals that were ceased about 10 years ago. At that time, the more hazardous internal chemical processes were neutralized and drained; however, some site processes may still contain the original process materials. The building has been essentially unoccupied for 10 years and its roof leaks when it rains. What potential problems would you immediately anticipate and how would you tentatively assess their health risk? (The building has never contained any radioactive material, so protection by radiological controls will not be in place).

Answer a

1. Asbestos containing material is probably present on the ceiling and around pipes and vessels and may be in poor condition from water damage. The risk should be slight until renovation begins, at which time vibration, air movement, or contact may cause potential exposure problems. Occasionally, asbestos materials degrade into forms that become airborne very easily and could present a health risk to inspectors, planners, and others who enter the space before controls are established.

2. Lead and other anticorrosive paints will also be present and in poor condition. Irrespective of condition, risk is slight until removal of paint begins.

3. The chemical processing system, exhaust ducts, hoods, filters, glove boxes, etc., may still contain quantities or residues of process chemicals. Detailed information on chemical agents and processes will be necessary to determine levels of control needed during renovation. Where remnants of unit processes involving chemicals exist, liquid or vapor leaks may occur at inopportune moments and emergency action may be needed. Solid residues should only be a problem during dismantlement. Air sampling data generated during the days of process chemistry should also give an idea of potential current chemical contents.

4. A wide variety of biological hazards may be present. These may include fungi in bird droppings, or fungi or bacteria, antigens, or toxic metabolites if a source of nutrients and excessive moisture are present. Biting mammals or insects may also inhabit the building. The fungi will be of no danger until disturbed. When renovation begins, fungi should be treated with caution.

5. Confined spaces may be present that would, under OSHA regulations, require Confined Space Entry permits. Personnel entering the building should be able to identify these spaces and avoid them. Personnel assigned duties covered by this regulation should be appropriately trained and qualified.

Question b

Plans have changed; it is now announced that the building will be decontaminated and decommissioned. The contractor prepares a safety and health plan for the dismantlement and cleanup. You are requested to review and approve it. What hazards, controls, monitoring, and medical surveillance requirements would you expect to see listed in the safety and health plan?

Answer b

1. If asbestos insulation is present, rigorous controls in accordance with 29 CFR 1926.1101 will automatically have to be implemented. Monitoring and medical surveillance will be required. Lessor controls may also have to be implemented for floor tile or transite panel removal.

2. If lead paint is present on structural elements, elevated levels during removal may require implementation of a program in accordance with 29 CFR 1926.62. Exposure controls and initial biological monitoring will almost certainly be required, but the need for continuing medical surveillance and biological monitoring will be determined by actual exposure levels and the frequency of exposure.

3. If plant history suggests the presence of process chemicals listed by DOE as carcinogenic, then relatively stricter control measures may be required if an exposure assessment determines that significant exposure is possible.

4. When other significant chemical exposure is possible, professional judgment should determine the level of control required until monitoring determines actual exposure levels. Professional judgment will also determine the need for controls and surveillance when exposure is known to be less than but approaching allowable levels. Medical surveillance and training needs should be determined by the level and frequency of exposure anticipated.

5. If bird droppings or nests are present, air-purifying respirators with HEPA filtration should be worn during their removal. Although the risk of illness is low, the potential presence of mycotoxins in association with certain microorganisms is a complicating factor because air-purifying respirators may not provide protection for these agents.

6. In warm weather and when the level of activity is intense, heat stress may be a problem. The potential of heat street is much greater when full protective clothing is required.

7. The use of vehicles and power tools indicate the potential for whole-body and half-arm vibration, which may exceed allowable limits (ACGIH TLVs for vibration), depending on the tool/vehicle used and the duration of exposure. If significant exposure is likely, the reduction of exposure time may be necessary and medical surveillance may be desirable.

Question c

You finally decide to take a walk through the building and see for yourself if there is anything the contractor may have missed. One thing you do notice throughout the plant is the presence of many broken gauges on the process equipment and in the laboratories. Many of these gauges are over pits, sumps, or porous surfaces. Could this be a problem?

Answer c

You may want to find out whether any of these gauges contained mercury and, if so, whether there is documentation of how they were drained. If these gauges did contain mercury, it may have run into cracks, pits, sumps, or porous surfaces, and may remain an exposure problem for years. Because of potential exposure to employees working in their proximity, it might be a good idea to take samples for mercury in these areas while in the process of characterizing the hazards in the building before work begins.

This scenario supports the following competencies: IH 1.1, 1.2, 1.5 - 1.9, 4.3, and GTB 5.5.

Scenario 5: ***The Smell in Plant 13***

Question a

One day your office receives a complaint about an operation in progress in a currently inactive chemical process building. It is reported that contractor employees are experiencing headaches and nausea as a result of organic vapor-type odors circulating within the building and coming from the building. How might you most efficiently proceed?

Answer a

Find the DOE employee responsible for this building, i.e., the project manager, building landlord, or operable unit manager, and ask about any operations currently ongoing in the building. Going out to the site immediately would be necessary if the complaint appeared to involve an IDLH situation, but otherwise it is probably better to adhere to the "chain of command" to avoid possible communication problems.

Question b

You find the building manager and he informs you that a couple hundred feet of the exterior of a process chemistry system are being repainted. The nearest personnel to the painting operation would normally be 50 to 100 feet away and would be performing miscellaneous maintenance operations. Because the specifications did not require the application of any exotic materials and the painting was being performed in essentially an open bay atmosphere, it was believed by reviewers that no special controls or contractor qualifications were necessary. As a consequence, a needy small business, the ACME Painting Company of Pike County, Ky., was contracted and offered a bonus to get the job done in two days. You are also informed that this subcontractor has never worked on the site before and no one is really familiar with its work. How might you next proceed?

Answer b

You review a copy of MSDS for the "unexotic" paints being applied and find that the paints contain only the garden variety of organic solvents and pigments. You are aware of the rule of thumb that it is almost impossible to exceed a solvent PEL in any normally ventilated space. You are aware that the complaints from employees about unpleasant odors and symptoms are probably over-reactions by personnel unfamiliar with the odors. Nonetheless, the use of small subcontractors should set off alarm bells, as should the subcontractor's apparent desire to wrap the job up as quickly as possible. As a result, you decide to go out and have a look at the operation.

Question c

At the site, you cannot find ACME and are informed that the workers have gone home for the day, but will be back the next day to finish up the job. You observe the containers of the paint they are applying and verify the hazardous contents of the paints to be the usual solvents and pigments, xylene, toluene, ethyl benzene, mineral spirits, and titanium dioxide. A few employees who had been working 50 to 100 feet of the painting operation voiced complaints about the odor during the painting, and said that one employee working adjacent to the painting went home sick. You smell nothing. What do you do next?

Answer c

Prepare to come back the next day. Because of the employee complaints, and the potential compensation and labor relations implications, it is probably necessary to document exposure levels for the record. You direct the preparation of personal sampling pumps for integrated sampling. Because you want to be able to assess exposure "real time," you pack detector tubes and charge up the portable gas chromatograph. When ACME arrives to begin work, you are waiting.

Question d

ACME personnel are not happy to see you. You have already been informed by the DOE Contract Officer's Technical Representative (COTR) that the subcontractor is under no obligation to allow you to sample ACME personnel, and that no interference with the subcontractor will be allowed for fear of incurring a penalty. Because maintenance and operations personnel working in the area will be going in and out, you decide that monitoring them would not be worthwhile, so you set up your pumps as area monitors at varying distances from the painters. The painters begin work; your industrial hygiene technician remains about 50 feet from the painters and pulls detector tubes and monitors the portable gas chromatograph. You go back to your office to get some work done. When you return, the subcontractor has "finished" and left. Your technician is packing up, but shows you detector tubes demonstrating exposure to up to four times the TLV for each of several solvents with similar readings

on the portable gas chromatograph. Because the technician was showing these detector tube readings to anyone who wanted to see them, several organizations, including the Fire Department, Legal, Building Manager, and Project Manager are now upset and want an immediate judgment on the health and compliance implications. The COTR is also upset because he blames your industrial hygiene technician with his detector tubes for scaring off the painters. What do you do?

Answer d

You promise them a written response when the integrated samples return from the laboratory because this sampling should be by far the most accurate. You inform them that the direct reading instruments are liable to positive interferences from the mixture of similar solvents and that the technician should not have revealed the detector tube results without emphasizing the uncertainty of such data. Also, you instruct the technician on how to handle future similar situations.

Question e

The results return from the laboratory and you note that the readings of direct reading instruments were running 10 to 50 times higher than integrated sampling results. The results from the laboratory show that the highest area sample for any solvent was about 25% of the TLV. This indicates that any contractor or DOE employee who had remained at this point for an entire shift could have received an exposure near the TLV because of the additive effects of the four solvents, but would not have received that level of exposure because personnel were going in and out. What ACME workers were exposed to is uncertain, but it undoubtedly exceeded the TLV. However, under the contract as written, the subcontractor was responsible for compliance with applicable regulations, which it demonstrably failed to do.

What are the lessons learned from this episode?

Lessons learned include the following:

1. Because of differing sensitivity to odor and differing meanings people assign to certain odors, the sense of smell is not a reliable indicator of exposure. In this case, personnel working on the edge of the operation found the odor objectionable and even experienced symptoms. The industrial hygiene technician working much closer noticed the odor, but felt okay. Not surprisingly, the professional painters, ACME, were by all accounts unconcerned.

2. One should be concerned about subcontractors with no track record of performing satisfactory work. One should be doubly concerned when the subcontractor is not obligated to demonstrate any safety and health qualifications before performing the job. DOE contract officials should keep in mind that DOE Orders 5483.1A and 440.1 as well as policy statements require the flow down of safety and health provisions to subcontractors.

3. It is really very difficult to achieve exposure in excess of the TLV for most solvents. It is, however, possible when an operator is given a financial incentive to get a job done (e.g., paint a large surface) quickly with no consideration for maintaining adequate job safety.

4. Personal observation can be very useful, no matter how routine the operation may seem at first; you may see something that will surprise you.

5. Direct reading instruments may be unreliable. Become familiar with their potential weaknesses, especially with potential interferences.

6. When in doubt, always perform sampling with a reliable, standard method. Having this sampling data available may save your career.

7. Counsel your technicians to avoid providing guidance not within the purview of their knowledge and authority. Have them direct questions to qualified personnel.

This scenario supports the following competencies: IH 1.5 - 1.8, 1.12, 1.14, and 1.15.

Scenario 6: ***Question***

You are assigned to audit the industrial hygiene activities in a chemical processing building. The building houses production workers and maintenance employees who are involved in building equipment maintenance and inspection/testing of plant and product systems. Because of routine high noise exposure, all personnel in the plant are on the Hearing Conservation Program (HCP). The following summarizes the past sampling results and current controls for the different work groups:

Group A

Each category of production worker has been sampled at least twice for the three principal likely chemical contaminants from the process, more than 10 working days apart, in first shift operations that are considered typical for that work group. The contaminants sampled are not classified as carcinogenic by DOE, but two of the constituents do have the same target organ. The most "at-risk" group has been sampled about 15 times. No sampling has been performed on second or third shifts, since these operations are considered similar to first shifts. The average concentration for individual chemicals is less than 10% of the TLV, with the highest concentration observed (of about 50 samples) being about 25% of the TLV. Engineering controls, including certain local exhaust ventilation systems, are in place and are tested annually to verify their continued operation. The employer requires that personnel wear hearing protection, but no other controls or medical surveillance programs are in place.

Group B

About one third of the maintenance workers have been sampled for exposure to the principal chemical contaminants of the operation during their maintenance activities. The average concentration observed is about 5% of the TLV, with the highest concentration observed being about 13% of the TLV. Each of the maintenance workers does specialize in a different craft (welding, plumbing/pipefitter, mechanic/ sheetmetal, carpenter, painter), and no sampling has been performed for exposure unique to their crafts. For these particular workers, however, a significant volume of sampling data exists for other personnel doing similar jobs within the complex. This sampling suggests that overexposure during any craft operations is unlikely. No maintenance personnel are assigned asbestos or lead work, and procedures are in place directing the avoidance of activities where potential exposure to these agents is possible.

The welder may be required to wear a respirator when performing hot work in the plant because of potential exposure to a metal fume other than lead and cadmium. In the shop, local exhaust ventilation is available. Other than hearing protection, no other personal protective equipment or medical surveillance is required is required; the welder (who is 25) was medically qualified to wear the respirator almost four years ago.

Group C

The testers/inspectors work in the plant only about 20% of the year, spending the rest of their time in an air-conditioned office offsite. Sampling has been performed on each inspector in the last two years and 18 of 20 samples have averaged about 2% of the TLV. The remaining two samples, however, showed different individual chemical concentrations of 55% and 60% of the TLV. The industrial hygiene technician who was monitoring the sampling cannot account for these results. The testers/inspectors are included HCP and do wear hearing protection when in the plant area, but are not included in any other medical surveillance program.

For each of the groups listed above,

1. Determine whether the contractor **must** perform additional sampling to characterize employee exposure. Why?

2. Evaluate whether contractor controls are **adequate** (why or why not?)

3. Recommend potential areas for future examination.

Scenario 6: ***Answer***

Group A

1. Sampling is adequate. The operation is well-characterized although samples are not sufficient to demonstrate 95% probability of lack of overexposure because of highest sample concentrations.

2. Annual testing of local exhaust ventilation is probably adequate, although in OSHA expanded standards, quarterly testing is required for ventilation needed to control exposure. Employees probably don't need medical surveillance because cumulative exposure of two chemicals acting on the same organ can statistically be demonstrated to be at their highest only about 20% of the TLV.

3. Second and third shift sampling is desirable, and is required in certain OSHA expanded standards.

Group B

1. Sampling is adequate unless evidence indicates these personnel have potential for significant exposure not characterized by the sampling of other craft personnel.

2. No additional medical surveillance or assessment is required. ANSI Z88.6, the most appropriate guidance, recommends medical assessment of respirator wearers every five years for employees under age 35 (this assessment is required annually for certain exposures not present in this scenario). The local exhaust ventilation in the welding shop **should** also probably be tested annually because the welder is relying upon it, although this is not required by any mandatory standard.

3. None.

Group C

1. Sampling is adequate, although the two high samples are disquieting, especially given their lack of explanation.

2. Controls are adequate. Given the individual high chemical exposures, exposure above the TLV cannot be statistically ruled out, but seems very unlikely. Were the employees exposed near 50% of the TLV routinely (about 30 days per year), medical surveillance would be required. However, they are only exposed for about 50 days per year and only 10% of the samples have been high.

3. It would be desirable to sample these employees during what is believed to be the worst-case situation, and to monitor their activities closely to determine the reason for the infrequent high exposure.

This scenario supports the following competencies: IH 2.1 and 2.2.

Scenario 7

In the performance of an assessment for DOE, determine how one might evaluate contractor actions in the following situations.

Specifically:

- Identify the **mandatory** DOE reference that provides the limiting guidance.
- Determine whether the contractor has achieved **compliance** with **mandatory** DOE guidance.
- If necessary, describe any additional considerations relating to good practice that may not be addressed in the **mandatory** guidance.

Question a

Representative air sampling demonstrates that contractor employees are exposed to mineral wool fibers in eight-hour TWA concentrations of up to 600 mg/m^3. The contractor is requiring personnel potentially exposed to these concentrations to wear full facepiece air-purifying respirators with high-efficiency filters.

Answer a

- When guidance is provided in more than one DOE mandatory source, the most protective is invoked. The allowable limit for mineral wool fibers is found in the ACGIH TLVs and is 10 mg/m^3; 29 CFR 1910.1000 Table Z-3 allows 15 mg/m^3. Recommendations such as those made by NIOSH that exposure be determined by fiber counting are not mandatory in DOE. The protection factor (PF) for respiratory protection in this situation is found in Table 1 (page 6) of ANSI Z88.2-1992 and is 100 for the type of respirator selected.
- Assuming the overall adequacy of the respirator program, adequate protection is provided and the contractor is in compliance with DOE policy.
- Despite apparent compliance, the exposure level is so high that the DOE industrial hygienist may have concern about employee exposure if mineral wool is someday determined to be more dangerous than is currently believed.

Question b

For the above situation, the contractor allows personnel visiting the work area for five minutes or less to enter without wearing respirator.

Answer b

- The same references apply.
- Given the TWA concentration, the contractor is probably in compliance because it would appear unlikely that, given the administrative control provided by limiting exposure duration, a visitor would exceed the TLV, especially given the likelihood that the visitor would remain relatively far from the area of highest employee exposure while in the work area.
- Because the sampling was only performed over the entire day and there is no detail about exposure during heaviest work activity, the industrial hygienist might have concern about the potential for uncharacterized short duration exposures that are so high that even the visitor could be overexposed if he appears at the wrong moment. "Keeping a stopwatch" on visitors for compliance with this administrative control would also obviously be difficult.

Question c

Representative air sampling demonstrates that contractor personnel are exposed to inorganic lead concentrations of up to 2700 ug/m^3 during the removal of old paint prior to building demolition. Contractor personnel perform these operations for more than 30 days per year and are required to wear full facepiece air-purifying respirators with high-efficiency filters.

Answer c

- In this case, both exposure criteria and respirator selection are described in 29 CFR 1926.62. The PEL is 50 ug/m^3 and respirator requirements are listed in Table 1; ANSI Z88.2-1992 does not govern because the guidance in the CFR is more protective.
- The contractor is out of compliance because the CFR allows only a PF of 50 for a full facepiece air-purifying respirator with high-efficiency filters, not the 100 PF allowed in ANSI.
- The industrial hygienist might also be concerned because of the apparent contractor inability to successfully implement engineering controls sufficient to reduce the concentration of lead dust below the current very high level.

Question d

For the above operation, the contractor does initiate engineering controls that lower TWA concentrations to consistently under 20 ug/m^3. As a result, contractor personnel performing this job are no longer provided with respiratory protection and no longer receive medical surveillance and biological monitoring. Several contractor personnel, however, complain to DOE demanding they be issued respiratory protection and continue to receive medical surveillance and biological monitoring.

Answer d

- The applicable reference is 29 CFR 1926.62.
- The employer is partially out of compliance; paragraph (f) (1) (iii) requires that any employee exposed within the context of the standard will be issued a respirator if they desire one. Paragraph J, however, only requires the employer to offer medical surveillance and biological monitoring if employees are exposed at or above 30 ug/m^3 for 30 days or more per year. Consecutive air samples performed more than seven days apart and indicating levels in air to be less than 30 ug/m^3 would demonstrate the lack of need for medical surveillance.
- The question naturally arise as to where one draws the line with respect to employee **requests** for respirators in the context of this standard. Presumably, when the employee actually performs the removal of lead-containing material or is exposed to significant quantity, even if not overexposed, they should receive a respirator if they want it. Where, however, the employer can demonstrate that exposure is not detectable or negligible, it may be acceptable to deny the employee a respirator. With respect to the decision to end medical surveillance and biological monitoring, one might want to consider whether sufficient air monitoring or the results of air monitoring really technically justify the decision to end medical surveillance and biological monitoring, even though it was legally justified.

Question e

In evaluating maintenance operations, you encounter several products containing trichloroethylene that are used infrequently and for short durations. Past sampling during representative operations demonstrate TWA exposure levels to be always under 5 ppm. The likelihood for skin contact is slight and there seems to be adequate personal hygiene. Because of the conditions of exposure observed, no controls are imposed on the use of these compounds.

Question e

- The ACGIH TLVs provide applicable guidance limiting TWA exposure to 50 ppm and STEL to 100 ppm; 29 CFR 1910.1000 allows a TWA of 100 ppm. DOE Orders 5480.10 and 440.1 both require the initiation of a Carcinogen Control Program if the industrial hygienist believes that additional controls are needed to control exposure, but this program is only to be initiated in the case of OSHA or ACGIH A1 and A2 carcinogens. Trichloroethylene is an ACGIH A5 carcinogen.
- The contractor is in compliance. Although NIOSH regards trichloroethylene as a carcinogen, their recommendations are not mandatory in DOE. ACGIH does not list trichloroethylene as a skin poison, so percutaneous absorption should be minimal.
- The carcinogenicity of trichloroethylene has been widely disputed and it is most unlikely that there will be adverse consequences of exposure at the level shown, however, **employer liability** in a compensation or torte action resulting from employee exposure cannot be discounted given the weight that NIOSH's recommendations may have in some quarters. In order to avoid this situation, it might be recommended that the contractor cease altogether the use the trichloroethylene onsite.

This scenario supports the following competencies: IH 1.1 and 4.5.

Scenario 8: ***Question***

As an industrial hygienist reporting to the production supervisor of a waste tank farm management operation, you're asked to review and approve a work package on Aug. 14 for a job that is due to start on Aug. 16. The job is to install a large mixing paddle into a 2,000-gallon tank containing mixed chemical and radioactive waste. The paddle is designed to combine the liquid and solid wastes into a slurry before it is pumped to a nearby waste treatment facility.

Upon reviewing the work package, you find that:

- Installing the paddle will require cutting through the tank and welding new fittings to the tank. This will result in a large breach in the tank for several days.
- A tent will be installed around the breach in the tank to help contain environmental emissions.
- Workers will wear full-face air-purifying respirators and nonpermeable protective clothing when working within 15 feet of the breach.
- Tank wastes and headspace have been well-characterized and the hazardous agents of concern are corrosives, radioactive materials, and carbon disulfide at 450 ppm in the headspace.
- A Radiation Work Permit will be required.
- The IDLH for carbon disulfide is 500 ppm.

As far as you can determine from a review of the sampling data bank, no air monitoring has been performed during similar operations carried out in the past, so you are unable to estimate actual exposures.

1. List your principal concerns about this scenario.

2. Provide solutions to your concerns.

Scenario 8: ***Question***

1. List your principle concerns about this scenario:

The principal concerns about this scenario in general are that worker protection provisions are not sufficiently detailed, and the time allowed for the industrial hygiene review is inadequate

- ***Poor work planning:*** Two days is clearly inadequate to review a work package for a job with the complexity and risk of installing a mixing paddle in a tank of mixed wastes. A credible review will require a fairly detailed evaluation of the job tasks and a job hazard analysis of the individual tasks.
  - ***Solution:*** Unfortunately, production supervisors often request safety and health reviews at the last minute. Nonetheless, the responsible industrial hygienist must conduct a competent review of work packages and request changes even if this means disappointing a production manager. Enhanced work planning that includes the worker safety professionals in the planning stage of the work package rather than viewing these professionals as reviewers of presumed completed packages can usually avoid these unproductive situations. The information required to complete the industrial hygiene component of the work package can be either in the package or referenced by the package and attached to it.

- **Cutting and welding permit not addressed:** Cutting and welding requires a permit, that is not explicitly required by the work package.
  - ***Solution:*** A written permit must be identified in the work package in order to meet OSHA requirement 1910.252(a)(2)(iv) "Authorization." Before cutting or welding is permitted, the area must be inspected by the individual responsible for authorizing cutting and welding operations. He shall designate precautions to be followed in granting authorization to proceed preferably in the form of a written permit.

- ***Engineering controls:*** The use of engineering controls to reduce or eliminate the hazards is not explicitly addressed in the work package.
  - ***Solution:*** Engineering controls are the most effective way of reducing exposure. The best protection is to enclose the operation and/or provide local exhaust ventilation. Specific engineering controls are recommended for this chemical by the National Institute for Occupational Safety and Health (NIOSH); refer to the NIOSH criteria document, "Carbon Disulfide #77 156."

- ***Marginal respiratory protection***. The 1996 ACGIH Threshold Limit Values (TLV) for carbon disulfide is 10 ppm and the nominal protection factor for full-face air-purifying respirators is 100, which would result in a nominal inhaled concentration of carbon disulfide of 450/100 or 4.5 ppm. However, the IDLH for carbon disulfide is 500 ppm. Considering that concentrations of volatile organic vapors like carbon disulfide are often highly variable, the use of a Positive Pressure Self Contained Breathing Apparatus (SCBA) at the onset should be considered.
  - ***Solution:*** Strictly speaking, a protection factor that would bring the inhaled concentration of an air contaminant to below the exposure limits seems adequate, but the real world is not so well-ordered. Prudent practice suggests starting the job with Self Contained Breathing Apparatus, an atmosphere-supplied respirators with a five-minute escape pack could also be used accompanied by monitoring the carbon disulfide because of the likely variability of the carbon disulfide concentration and the need to verify the actual protection afforded by respirators. 29 CFR 1910.134 requires that at least one additional employee be present in areas where the wearer, with failure of the respirator, could be overcome by a toxic or oxygen-deficient atmosphere. The standard also requires that communications (visual, voice, or signal line) be maintained between all individuals present. Planning shall be such that one individual will be unaffected by any likely incident and have the proper rescue equipment to be able to help the other(s) in case of an emergency. The work package could allow downgrading the respiratory protection after monitoring demonstrated consistently low carbon disulfide levels. The following provides the legal limits for exposure to carbon disulfide.

- OSHA's ceiling and peak exposure limits

Table Z-2

Substance	eight-hour time-weighted average	Acceptable ceiling concentration	Acceptable maximum peak above the acceptable ceiling concentration for an eight-hour shift	
			Concentration	Maximum duration
Carbon disulfide (Z37.3-1968)	20 ppm	30 ppm	100 ppm	30 minutes

- ***Inadequate heat stress control:*** No mention is made of controls for the high-heat stress condition likely to occur to those working outdoors in impermeable clothing in August.
  - ***Solution:*** Outdoor work in impermeable clothing in August presents a potential heat stress condition. The work package must call for heat stress monitoring and controls (body temperature and effective ambient temperature monitoring, work-rest schedules, cooling and shade when possible, and perhaps monitoring water loss and vital signs).

- ***Inadequate specification of protective clothing:*** No mention is made of the extent of skin that will be covered by the clothing or the clothing material that will resist penetration by both carbon disulfide and corrosives.
  - ***Solution:*** The package must detail the type of clothing to be worn to ensure adequate coverage of the skin. Level B clothing appears to be sufficient. The package should provide cautions if the protective clothing material available is limited in resisting permeation or degradation from the corrosives and organics that will be contacted. The protective clothing selected must be compatible with all chemicals liable to be encountered. ACGIH recommends polyvinyl alcohol (PVA) or viton as a good to excellent protective material. However, it must be remembered that PVA is soluble in water or water-based solutions. The AIHA recommends the use of neoprene, polyvinal chloride, or nitrile butadiene rubber as protection against carbon disulfide.

- ***Inadequate specification of decontamination:*** No mention is made of decontamination procedures to handle the corrosive and radioactive contamination of clothing, tools, and equipment.
  - ***Solution:*** The package must include decontamination procedures for personnel, equipment, and supplies since a tank breach will result in contamination of personnel, their clothing, tools, and equipment.

- ***Inadequate specification of airborne carbon disulfide monitoring:*** The National Fire Protection Association (NFPA) rates carbon disulfide as a chemical that is highly volatile and presents an extreme flammability hazard. With the breach in the tank being enclosed in a tent, and the work requiring welding, it would be prudent to specify monitoring for flammable and explosive atmospheres prior to lighting the torch. Inhalation exposure monitoring should be carried out to ensure that actual exposures potentially occurring to workers wearing respiratory protection falls within DOE prescribed limits.

  - ***Solution:*** The package must include monitoring of carbon disulfide to verify that the percentage of vapor in air is below 10% of the LEL. Verification that the level of respiratory protection is adequate will also be required. Monitoring will be necessary to support downgrading respiratory protection to full-face air-purifying if initial monitoring data allows the downgrading. Also, the package should identify any carbon disulfide monitoring that is needed to support the site's overall exposure monitoring strategy to obtain representative monitoring results for similarly exposed groups.

- ***Confined space entry:*** A possibility exists that this scenario might fall within the confines of 29 CFR 1910.146, "Permit Required Confined Space Entry."
  - ***Solution:*** An evaluation of the workplace to determine if any spaces are permit-required confined spaces has to be made in accordance with 29 CFR 1910.146. A confined space is a space that:
    - Is large enough and so configured that an employee can bodily enter and perform assigned work.
    - Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry.).
    - Is not designed for continuous employee occupancy.

    If the space is determined to be a confined space, then all of the requirements of 29 CFR 1910.146 must be met.

This scenario supports the following competencies: IH 1.2, 1.3, 2.1, 3.2, 4.5, and GTB 5.5.

Scenario 9: ***Question***

Three employees were performing radiological decontamination inside an unventilated containment structure. In accordance with the Radiological Work Permit (RWP), the employees were provided with powered air-purifying respirators equipped with cartridges approved for the control of airborne radiological contaminants. Work planners had required review by no other staff and no other permits were required or obtained. Bartlett TLC Stripcoat was used as the contaminant fixant and was being applied to a section of pavement inside the structure. After approximately 15 minutes, the employees noticed an ammonia-like odor. Work was stopped and the employees left the containment structure. One of the three employees had experienced burning eyes and nausea. This worker was given a medical examination and later returned to work without restriction. The other two employees experienced no symptoms. No monitoring was conducted for any air contaminant, but the Bartlett TLC Stripcoat MSDS did indicate that ammonia could be released during its use.

List major administrative program concerns raised by this scenario and determine whether the TLV for ammonia was exceeded.

Scenario 9: ***Answer***

Major Administrative Concerns:

1. There was definitely inadequate work planning. Only radiological hazards were identified and controlled, and only a RWP was required. The MSDS for Bartlett TLC Stripcoat was not reviewed by the planners prior to the operation, and the entire work package was not reviewed by an industrial hygienist. As a result, potential chemical exposure was not anticipated and recommendations for controls by qualified personnel were not made.

2. There may have been inadequate implementation of the Hazard Communication Program. Without the review by an industrial hygienist, it was especially important that supervisors and workers be familiar with the compounds they would be working with as well as the compounds' hazards. However, neither supervisors nor employees had been or could remember being trained in the hazards of, nor could they remember ever having read its MSDS. They were, therefore, unaware that they were not wearing the PPE recommended by the MSDS.

Exposure Levels of Ammonia:

The 1995-96 ACGIH TLV is 25 ppm for an eight-hour TWA, and 35 ppm for the STEL. Ammonia has an odor threshold of 1-5 ppm. Employees may experience headache and nausea within minutes of exposure to 40 ppm. Moderate eye irritation may occur at levels less than 30 ppm. At 72 ppm, many workers report eye, nose, and throat irritation.

Because no monitoring was conducted, the exact exposure cannot be known. However, given the excellent warning properties of ammonia and the type and degree of symptom experienced, it is at least possible that exposure to one of the employees may have exceeded the STEL. However, because the total exposure duration was only 15 minutes, it is very unlikely that the eight-hour TWA was exceeded for any of the three exposed workers.

This scenario supports the following competencies: IH 1.1, 1.3, 1.9, 4.3, and 4.5.

Scenario 10: ***Question***

As an industrial hygienist having oversight responsibility for the contractor safety and health program, you have been tasked with determining if the contractor should be implementing an ergonomics program. At the present time, the contractor addresses environmental heat-stress hazards and provides training on how to lift properly. An ergonomist is employed by the contractor, and, when requested, will review design plans.

With respect to the competency, outline the strategies you would use to determine if the contractor's program is sufficient, and, from the strategies, describe findings that might suggest the need for an ergonomics program.

Scenario 10: ***Answer***

Strategy:

1. Most databases of injury/illness statistics do not specifically flag ergonomically-related cases. However, it may be possible to identify incidents with potential ergonomics causes from a review of raw accident/injury reports. Therefore, you should perform a review of contractor injury and illness reports over the past three to five years to obtain a breakdown of incident and severity rates by type, body part, cause, occupation code or job description, work activity, and department in order to see whether patterns exist. One should also determine whether there are patterns over time and whether rates are increasing or decreasing. If standardized comparisons are possible, you should compare the rates you have calculated with those found in similar operations or industries.

2. Perform a review of compensation cases, identifying the direct and indirect costs of cases you have determined to be ergonomically related. As before, look for patterns in the compensation case history and the trends over the period.

3. Review medical complaint and incident reports to identify activities that may be producing injuries/illnesses, symptoms, or requests for medication that may be associated with ergonomic hazards.

4. Survey or poll work places for the presence of operations, activities, or equipment use having recognized potential for causing ergonomically related injury.

5. On the basis of some of the ergonomically related injuries/illnesses identified, determine whether any of the jobs in which these occurred would be classifiable as "Problem Jobs" in the OSHA Draft Proposed Ergonomic Protection Standard (March 1995).

Findings That Might Demonstrate the Need for an Ergonomic Program:

1. An unacceptable rate or concentration in one operation or location, of sprains/strains; disorders resulting from repeated trauma, fractures, or contusions; certain types of back, shoulder, arm, or hand injury; or cases of overexertion or any rate that is increasing.

2. An unacceptable rate or concentration of compensation costs for injuries/illnesses determined to be ergonomically related, or a compensation rate that is increasing.

3. An unacceptable prevalence or increasing rate of ergonomically related medical complaint.

4. The existence of unmonitored and uncontrolled operations, activities, or equipment use with the recognized potential for causing ergonomically related injury.

5. The existence of what would be categorized under the draft proposed OSHA Ergonomic Standard as "Problem Jobs."